Ph.D. DISSERTATION THESIS

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DEVELOPMENT OF SELECTION FOR BEEF PRODUCTION TRAITS IN HUNGARIAN SIMMENTAL CATTLE BREED

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1. SCIENTIFIC PRELIMINARS AND AIMS OF THE STUDY

Through centuries Hungary had been an exporter of beef and cattle for slaughter. During the last decades, amuont of exportable beef cattle has been decreasing, but the export orientation is still existing. Hungarian Simmental breed plays a large role in the production of high quality beef for export. To maintain or improve the present level, it is inevitable to use modern breeding methods in everyday practice.

Breeding value estimation of dual purpose cattle breeds raises many theoretical and practical problems. Expressing and evaluating together the progeny differences of many traits, that are often antagonists to each other, is accused with compromises. There are great differences between traits – milk production, beef production, fitness – in measurability, in performance-testing system, and simply in availability of data (**Dodenhoff and Krongmeier, 2001; Sölkner and Miesenberger, 2001)**. Above these, knowledge of genetic parameters (heritability, correlations, variances) is still incomplete.

Guba and Stefler (1981) also drew the attention to the fact that among the factors effecting breeding goal, demand and supply rate for cattle products (milk and beef) has to be regarded in the first place.

These reasons are urging to carry out an intensive research work for gaining the lacking information in the Hungarian Simmental breed, otherwise it is impossible to keep competency with other breeds.

Research work is hardened by the situation, that at the moment, most of the bull calves and fattened bulls are exported, so they are slaughtered abroad. As a result of it, there are very few data available on fattening and slaughter results (boning and yield traits, beef quality) of cattle of different breeds, -genotypes, and –sexes. Without knowledge of those parameters, successfull selection work is impossible.

For a long period, breeding value estimation of the dual purpose Hungarian Simmental cattle was based on dairy traits only. The main reason for it was the fact that improvement of dairy traits was set as a breeding goal, in order to reach 5000-6000 kg milk production per lactation as it is required in European Simmental breeds. Presently this demand is fulfilled, so improvement of beef traits has become important as well. Association of Hungarian Simmental Breeders, which is responsible for improvement of the breed, was ambitious in this intention by involving beef traits (frame, muscularity, body conformation, udder conformation) in type classification as the first step (1992), then by initiating the setting up of central self-performance testing of sire candidates (from 1994), which is a help in choosing the bulls with best weight gain traits for artificial insemination. It is obvious that phenotypic data related to beef production give insufficient information on the progenies of sires, since estimation of slaughter traits is not possible. On the other hand, requirememts for slaughter traits and beef quality are getting higher and higher in high quality beef production. Compatibility can be ensured only if the population of the breed is selected for these traits as well.

Facts written above account for progeny testing the bulls for beef traits in Hungarian Simmental breed, and for involving its results in breeding value estimation of breeding bulls. Experiments of the author are intended to support this effort.

Based on the situation introduced above, aims of this study were as follows:

3.1. Among the centrally self performance tested Hungarian Simmental sire candidates, selecting a sample population of bulls that exceed the average of the whole population, and to arrange a progeny test for the sample population (which are qualified for artificial inseination).

3.2. Collecting individual data on the fattening and slaughtering traits of progeny groups:

- type classification muscularity score before slaughter
- weight gain (daily gain in total life, daily gain in test, net weight gain)
- carcass yield percentage
- EUROP muscularity of carcasses
- EUROP fattyness score of carcasses
- lean meat %

3.3. Calculating basic genetic parameters based on data of progeny groups:

- heritability (h^2 values)
- correlations (r values)
- environmental factors remarkably affecting examined traits, rate of influence.

3.4. Developing a breeding value estimation model for fattening, slaughtering and boning traits.

2. MATERIALS AND METHODS

2.1. Self performance testing of sire candidates and selecting the sample population

According to the rules of Cattle Performance Testing Codex, Association of Hungarian Simmental Cattle Breeders re-started to organize central self performance tests in 1994. Housing and nutrition technology, and duration of the test are prescribed in the Codex **(Szarvasmarha Teljestményvizsgálati Kódex, 2002).** At the end of the test, bulls were evaluated regarding gain in test, type classification score, and production of the dam. Sire candidates were then grouped as follows:

1. bulls qualified for artificial insemination (can be put into beef progeny test)
2. bulls qualified for natural mating
3. bulls for slaughter

2.2. Progeny testing of sire candidates

Bulls qualified for artificial insemination were put into beef progeny test. In Hungarian Simmental breed, approximately 70 thousands doses of semen is used yearly, out of which 5 thousands of doses are semen of bulls under progeny testing. This takes the 7-9% of the total inseminations. 29 sire candidates of the 4 years were put into progeny test under 8 license numbers between years 2000 and 2003. The first beef progeny test started on 03. 05. 2000.

Among the male progenies born, 12-15 calves per sires were fattened. Only sires with available data from at least 10 progenies were involved in the evaluation.

Fattened calves were randomly selected for slaughter, respectively to date of birth. Bulls were chosen which represented the whole progeny group born on the certain farm.

2.2.1. Housing and nutrition technology during progeny testing

Bulls were fattened on 12 farms. On every farm, bulls were kept untied, on growing litter, in opened stalls with excercise yard. Resting area on average of the 12 farms was 4.2 m^2/animal. Resting place was littered on every second day with wheat straw. Area of excercise yard was 2,4 m^2/animal. Nutrition was based on ad libitum maize silage, 1.5-2.0 kg hay per day, and limited amount of concentrate (1 kg per 100 kg live weight per day; compounds: 40% maize grain, 30 % wheat grain, 30% CGF).

2.2.2. Collecting data in progeny test

When selecting progenies for fattening, the following data were collected: individual identification number, identification number of dam, date of birth, individual identification number and central list number of sire. At the beginning of fattening period, date and live weight were noted. At the end of fattening, date and final weight were collected. Duration of test and weight gain in test were calculated as well as daily gain in life, in test, and net weight gain. At the end of fattening, muscularity of bulls was scored by the official type classifiers of the Breeding Association on a 1-9 points scale.

2.2.3. Qualifying slaughter

Qualifying slaughters were carried out at Zalahús C.o., Zalaegerszeg, and at KO-BOR HÚS Ltd., Jászszentandrás. At arrival to slaughter house, weight of animals was measured.

For weight measurements, calibrated digital scales were used. Measurements were carried out with 1/10 kg accuracy. Weight of fat (abdominal and kidney fat, kg), and carcass weight (kg) were measured. After slaughter, carcasses were qualified according to the rules of (S)EUROP system. In the evaluation of muscularity, category “E” was signed with “1”, and category “P” with “5”. After 24 hours of refridgeration (4°C), right side carcasses of 3 progenies per sires were boned (n=68 right side carcasses altogether). Carcasses that best represented mean of the popuation were chosen for boning. Weight of right carcasses was measured before boning, to be able to calculate dripping loss. Right side carcasses were chopped according to the traditional German method. After chopping, bony meat weight of different parts of the carcass was measured (kg), then boning was carried out.

Beef was grouped into quality classes I., II., and III. Weight of bone (red and white), tendon and fat was measured.

Only data that are essential for calculation of breeding value and are simply to measure were involved in the evaluation.

2.3. Introduction of statistical tests

2.3.1. Evaluation of fattening data

Fattening data were evaluated with ANOVA where independent factor was year. Mean value, standard deviation, variation coefficient (cv%), minimum and maximum values, correlation and regression coefficients were calculated for each parameters. Differences between years were observed by LSD-test. The same method was applied when evaluating progeny groups by sires.

2.3.2. Sire model

Effect of environmental factors, population genetics parameters, and breeding values were estimated by sire model. Among the factors evaluated, farm and age at slaughter (categorised by months) were taken as fixed effects, while sire as a random effect. In case result of sire model revealed a significant effect, reliability of differences between effects of different factors was tested by LSD-test, using SPSS 9.0.

Genetic variance – variance between paternal half-sib progeny groups, and environmental (error) variance – variance in the same progeny group, were also estimated. Phenotypic variance was calculated as the sum of genetic and environmental (error) variances.

Heritability (h^2) was determined as the quotient of genetic- and phenotypic variance.

Data were prepared for evaluation in Microsoft Excel XP, and evaluation was carried out using Harvey's (1990) Least Square Maximum Likelihood Computer Program.

Breeding value indexes were calculated from breeding values of the different traits, using weighing factors applied in the common German, Austrian, Italian, Czech, and Hungarian breeding value estimation system. In the index, net weight gain represented 44%, while yield grade- and (S)EUROP muscularity breeding values 28% both. The explanation for the weighing factors is, that among the 3 tarits that determine beef breeding value, measurement of net weight gain is loaded with the smallest error, since it is not influenced by nutrition and starvation before slaughter. Yield grade is strongly influenced by rumen content, while EUROP muscularity score is loaded with subjective effects. Among the three traits, heritability of net weight gain is the highest (h^2=0.4-0.6) **(Guba, 1985)**. The high weighing factor for net weight gain increases the effectiveness of selection for high beef production.

This was the way of determining absolute beef index. To calculate relative beef index, average was taken as 100, and the index was the expression of difference from the average (100).

3. RESULTS AND EVALUATION

3.1. Self performance test and fattening results

Daily gain (both during lifetime and in test) of bulls qualified for artificial insemination – except the ones born in year 1998 – exceeded the average of total population put into self performance test. Since weight gains in central test exceeded those reached under farm testing circumstances, it seems obvious that to reveal genetic differences, nutrition requirements must be fulfilled.

Fattening results supported the fact that there are significant differences in weight gain traits between bulls born in different years. This phenomenon must be inevitably regarded when organizing progeny tests and also, when developing breeding value estimation models.

To urge the standardisation of progeny testing technology, effects of technological elements (duration of fattening, age at slaughter, etc.) on progeny test results were also evaluated.

It is a biological process that intensity of beef production decreases with age, which was also proven by the correlation coefficient (r=-0.62) in this study. Also, a negative correlation was observed between weight gain in progeny test and fattening final weight. These have to be taken into account when determinig optimal final weight. Weight gain in test showed a close positive correlation with weight gain during lifetime. This implies that uniform satisfying conditions in calf rearing influence weight gain in test positively, and vica versa, unsatisfying conditions in calf rearing have negative effect on progeny test results.

The conclusion is that success of progeny test is strongly depending on the uniformity in age and maturity of calves put into the test at the same date.

3.2. Main fattening and slaughter results of the sample population

Mean value for daily gain during fattening was 1250 g/day, which introduces the excellent growth rate of the breed (Table 1). This result exceeds the 1197 g/day data published by **ZuchtData (2008)** for Austrian Simmental breed. Maximum value was 2093 g/nap, which is an outstanding result.

Yield percentage was 59.11%, which is also higher than results published for Austrian Simmental (56.8%, **ZuchtData, 2008)** and German Simmental young bulls (57.5%, **Röhrmoser, 2004).** These differences can be explained by the different breeding goals set in the three different countries.

Table 1 | Fattening and slaughtering results of the examined Hungarian Simmental bull population

Trait	n	mean	sd	CV%	SE	min.	max.
Muscularity (1-9 scores)	352	6.35	1.28	20.17	0.07	3	9
Daily gain during lifetime (g/nap)	352	1180	171	14.50	0.009	779	1764
Daily gain in test (g/nap)	352	1250	215	17.23	0.011	736	2090
Net weight gain (g/nap)	352	661	103	15.58	0.005	374	1003

Yield percentage (%)	352	59.11	2.20	3.72	0.12	43.47	68.09
(S)EUROP muscularity (1-5 scores)	352	2.69	0.68	25.25	0.04	1	4
EUROP fattiness (1-5 scores)	352	2.52	0.51	20.27	0.03	1	4
Lean meat percentage (%)	68	70.9	2.09	2.95	0.25	66.16	74.97

Mean value for EUROP muscularity (2.69 scores: between U and R) is a particularly good result when speaking about a dual purpose breed. Distribution of type classification muscularity score shows that 89% of the slaughtered bulls reached at least the mean or even higher score. Tendency was the same in case of (S)EUROP muscularity score of carcasses: 89% of them were at least "R" quality. When scoring type classification muscularity, tigh profile is evaluated on a 1-9 scale, so scoring can be adjusted to categories of the (S)EUROP scale. Results indicate that type classification is useful in improvement of slaughter traits, especialy that of musculariry.

EUROP fattiness was between categories 2 and 3, which values are preferred by meat industry, since main export markets (Italian, Greek) require carcasses covered by a medium quantity of fat which protect muscle tissues from harmful effects of oxydation (change of colour) during transport and storage.

Mean of lean meat % was near 70% (70.9), which is a very good result in European respects as well.

3.3. Effect of genetic and environmental factors on fattening and slaughtering traits

Knowledge of the influence rates of each variance source affecting the selection traits is essential for an effective selection work. As it was observed, effect of sire was the largest in type classification muscularity score and in lean meat percentage. This indicates that selection for improvement of these two traits can be efficient, remarkable genetic progress can be realized in the population.

Traits characterising intensity of fattening (daily gain during lifetime, during fattening, net gain) are strongly influenced by age, so in fattening of beef bulls, consideration of biological factors and eoconomical optimum, which has a great influence on thrift of fattening, is very important.

In Hungary, carcasses have been qualified by yield percentage for a long period. This trait is affected by sire, farm (nutrition), and age at around the same level. Farm effect is caused mainly by different nutrition. Starvation or overfeeding before slaughter can distort results for this trait. This is the main reason why (S)EUROP classification was introduced in evaluation of carcasses to take over yield grade.

3.3.1. Effect of age at slaughter

Intensity of fattening declined with age, while amount of muscle (lean meat production) increased. These results are urging the reconsideration of elder fattening thecnologies, particularly the fattening of young bulls slaughtered at the age of 16-18 months. As a result of selection for dairy and beef traits, besides the improvement is milk quantity, a strong increase in body measurements (hip height, rump width, chest girth) was noticed in Hungarian Simmental cow population. It also means that meat production capacity of young bulls exceeds those of elder generations', so bulls can be fattened to a higher slaughter weight and to an elder age (even till 24 months of age) without an excessive fat production (Figure 1).

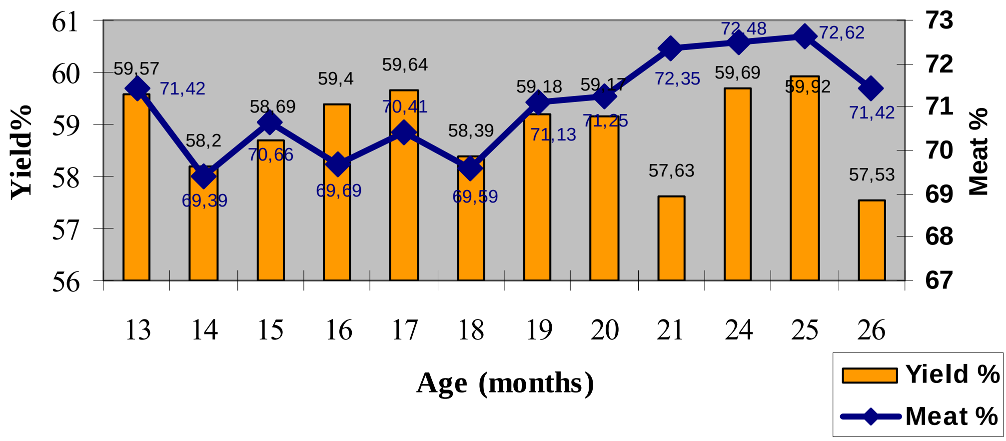

Figure 1 | Effect of age at slaughter on carcass yield- and lean meat percentage

3.3.2. Farm effect

Despite the efforts to uniformize fattening technology (nutrition, housing), farm effect remained remarkable, its elimination in ruminant species is impossible. That is why farm (environmental) effect always has to be ragerded in breeding value estimation.

No significant differences were found between farms in type classification muscularity scores. The largest weight gain results were measured on farm 30384 (daily gain during lifetime:309 g/day, daily gain in test:1428 g/day, net weight gain: 722 g/day). Daily weight gain during lifetime was the lowest on farm 32232 (1016 g/day). Carcass yield percentage (60.74%) and (S)EUROP muscularity score (3.27) were the highest on farm 30881, however, mean value for type classification muscularity score on this farm was among the lowest ones (6.28). EUROP fattiness score was the highest (2.85) on farm 30930. There were no differences among farms in lean meat percentage.

3.4. Performance of progeny groups from different sires

Based on the results of progeny test, it was concluded that there were significant, remarkable differences between progeny groups. In the same time, results and gradiation of the different traits are diverse. Among half-sib progeny groups, progenies from bull Nr. 15510 were the first in type classification muscularity score (7.12), while progenies of more other bulls exceeded them in (S)EUROP muscularity. Daily weight gain during lifetime was 1171 g/day on average, which was exceeded by 100 g by the progenies of bull Nr. 17367. Daily gain during fattening was also the largest for this bull (1384 g/day). However, net gain (bony meat production during lifetime) was the highest not for this bull, but for the one Nr. 16113. The highest value, 722 g/day net weight gain was paired with the highest carcass yield percentage result (60.04%).

Main mean value for fattiness evaluated by paternal half-sib bull groups was 2.74 scores. Mean for meat percentage was 71.01%, the highest value (72.64%) was reached by progenies of bull 16890, which was not exceeding the others in any of the traits evaluated so far (type classification muscularity, weight gain traits, yield %, (S)EUROP muscularity and fattiness). Its fattening performance was excellent, carcass yield was 58.46%.

These results imply that selecting for improvement of beef production traits does not result the same improvement in every single trait. Economical evaluations have to be carried out to determine the traits which's improvement brings the fastest and largest profit.

3.5. Heritability of fattening and slaughter traits

Heritabilities of the examined traits are shown in Table 2. Heritabilities of type classification muscularity score and (S)EUROP muscularity of carcass were different ($h^2 = 0.36$, and $h^2 = 0.52$, respectively). Heritability of carcass muscularity was higher than that of type classification muscularity score. This can be caused by the fact that muscularity of carcass is easier to be judged than muscularity of a living animal.

Table 2 | Genetic variance and heritability (h^2) of the examined traits

Trait	n	Additive genetic variance	Environmental variance	Heritability (h^2)
Muscularity (1-9)	352	0.20	1.45	0.36
Daily gain during lifetime (g/day)	352	3425.62	9558.21	0.59
Daily gain in test (g/day)	352	5575.76	19826.50	0.53
Net weight gain (g/day)	352	1324.90	3680.41	0.59
Carcass yield percentage (%)	352	39.03	427.15	0.27
(S)EUROP muscularity (1-5)	352	0.08	0.30	0.52
EUROP fattiness (1-5)	352	0.02	0.18	0.36
Lean meat (%)	68	112.79	334.51	0.57

Heritabilities of traits expressing growth (daily gain during lifetime, daily gain in test, net weight gain) were approximately the same ($h^2 = 0.53 – 0.59$), showing that they all express growth capacity. These values are a bit higher than expected, which is assumed to be caused by the more equalized nutrition and feeding technology compared to past years. This is a promising result from the point of view of success in selection work for growth traits. It is very important, being excellent growth traits the preconditions of economic feeding.

Heritability of EUROP fattiness was medium, h^2 = 0.36. This trait can be influenced by age at slaughter and nutrition in fattening period.

Carcass yield percentage had a low heritability (h^2 = 0,27). This result is similar to those published by **Rumph et al. (2007), Crews et al. (2003), Shanks et al. (2001), Hickey et al. (2007),** and **Ríos-Utrera et al. (2005)**. Heritability of this trait can be affected by rumen content at slaughter (starvation or overfeeding). Although an effort was made to standardize this in the technology, idividual differences in appetite could not be eliminated.

Heritability of the evaluated traits was a bit higher compared to those published between years 1970-90. **Karakoz (1964)** and **Cartwringht (1971)** calculated heritability of daily gain during fattening as 0.46 and 0.50, respectively**. Gravert (1962/63),** and **Preston and Willis (1974)** published data on carcass yield heritability: h^2 = 0.40 and 0.38-0.41. According to results of **Mészáros (1983)** heritability of daily gain during lifetime was 0.17.

3.6. Correlation between traits evaluated in progeny test

Correlation coefficients between type classification muscularity score, weight gain traits, and (S)EUROP muscularity were low, although significantly positive (P<0.01). This supports the fact that phenotypic selection for type classification traits (frame, muscularity) has a positive effect on most beef production traits (final weight, carcass muscularity).

Age at slaughter (months) showed strong negative correlation with weight gain traits (daily gain: r=-0.68; gain during fattening: r=-0.62; net gain: r=-0.68). These correlations are all significant. The longer the fattening period is, the higher the weight gain gets, since growth intensity and feed conversion rate decrease with age. In the development of fattening technology, it is useful to regard the result that fat cover of carcass did not increase until 26 months of age, so it is advised to reconsider the length of fattening period and final weight in Hungarian Simmental breed. This can be a reason for the weak negative correlation between EUROP fattyness score and age at slaughter ($r = -0.24$; $P<0.01$).

Correlation between slaughter weight, age at slaughter, total fat (in percentage of slaughter weight), kidney fat, boning fat content (in percentage of carass weight), and EUROP fattiness score were calculated, as well as their correlation with final weight and age at slaughter.

Results of correation analysis revealed positive relationships between EUROP fattiness score and amount of fat deposits (kidney fat, abdominal fat, intramuscular fat. Results also show that at this young age, fat deposition is not remarkable, nutritives of the feed are conversed mainly into muscle production. Intensive fat deposition begins after 24-26 months of age, over 600 kg body weight.

3.7. Breeding values

Presently, breeding decisions are based mainly on breeding values. In this study, Hungarian Simmental breeding bulls were ranked according to a beef index calculated by the author, and an index score calculated from results of international breeding value estimation system (Figure 2).

Evaluation of results show that the best bulls were among the first ones according to both calculation systems. This can be explained by the fact that domestic bulls that are stemming from foreign (German, Austrian) sires or grandsires, have many paternal or grand-paternal half-sib brothers producing in different (farm size, technology) German and Austrian environment. So result of breeding value calculated by Animal Model accounts not only with the performance of the certain animal, but also his relatives'. With the presently applied modern breeding value estimation methods it is possible to calculate a beef breeding value (pedigree breeding value) with a sufficient reliability (over 50%) without any slaughtering data on progenies of the certain bull.

Correlations were also examined between results of author's own breeding value estimation system and that of international estimation. Rank correlation coefficients showed that there was a medium correlation between the breding values of bulls calculated by the two different methods, which is caused by different population size and its different genetics. This is why international INTERBULL breeding value is the most suitable to make comparisons. This is a breeding value estimation carried out on the own base of each INTERBULL member countries.

Results above support that in the small active domestic population, advantages offered by the international Simmental population have to be exploited as well.

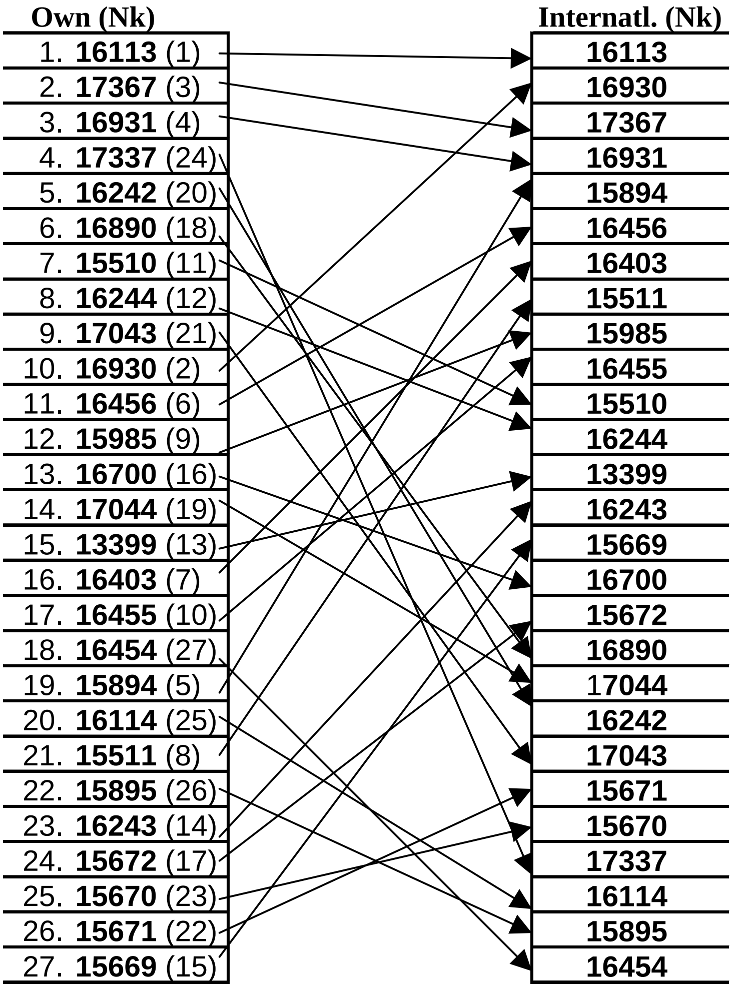

Figure 2 | Ranks of bulls set by author's own and international beef indices

4. CONCLUSIONS

Breeding value estimation of dual purpose cattle breeds is raising many theoretical and practical problems. Expressing and evaluating together the progeny differences in many traits, that are often antagonists to each other, is accused with compromises. There are great differences between traits – milk production, beef production, fitness – in measurability, in performance-testing system, and simply in availability of data. Above these, knowledge of genetic parameters (heritability, correlations, variances) is still incomplete. Application of modern breeding methods in everyday practice is inevitable in keeping or increasing the role of Hungarian Simmental breed in slaughter cattle production.

Evaluation of fattening and slaughter results of a relatively large (n=352) population of different sired (n=27) Hungarian Simmental bulls fattened under similar circumstances revealed that despite the consequent selection for dairy traits during the last decades, beef production traits as slaughter value and daily gain fulfil, or even exceed the requirements set in high quality beef production. Of course this does not mean that no further efforts are needed to improve these traits, especially slaughter value. Results also showed that heritability values calculated from the tested population, in case of yield percentage is the same as it was published decades before, however, in other parameters values they were a bit higher than expected.

Heritabilities of type classification muscularity score and (S)EUROP muscularity of carcass were different ($h^2 = 0.36$, and $h^2 = 0.52$, respectively). Medium heritability value of daily- and net weight gain ($h^2 = 0.59$) reveal that these traits are influenced mainly by genetic factors. Heritability of lean meat rate was 0.57, however standard error was surprisingly high and repeatability low. EUROP fattyness score had a medium heritability, h^2=0.36. This implies that this trait is strongly affected by age at slaughter and nutrition during fattening, which is a motivation to standardize these factors in progeny test. Heritability of yield grade was low (0.27), which means that this trait is not definitely necessary to be involved in the selection..

Correlation coefficients between type classification muscularity score, weight gain traits, and (S)EUROP muscularity were low, although significantly positive (P<0.01). Age at slaughter (months) showed strong negative correlation (P<0.01) with weight gain traits (daily gain: r=-0.68; gain during fattening: r=-0.62); net gain: r=-0.68) which support earlier findngs. Surprisingly, contradictory to some other publications, a weak negative correlation was revealed between EUROP fattyness score and age at slaughter (r = -0.24; P<0.01).

It was concluded that intensity of fattening declined with age, while amount of muscle (lean meat production) increased. It is assumed that during the last decades, as the effect of selection for dairy and beef traits, besides an increase in milk quantity, an increase in body measurements has happened as well. This is why meat production capacity of young bulls evaluated in the study exceeded those of elder generations', so bulls can be fattened to a higher slaughter weight and to an elder age (even till 24 months of age) without an excessive fat production. These results are urging the reconsideration of elder fattening thecnologies, especially in the fattening of young bulls slaughtered at the age of 16-18 months.

Regarding the calculated breeding values, there were remarkable distinctions between estimated progeny differences of different sires. Mean values of fattening and slaughtering parameters (daily gain in test: 1250 g/nap, carcass yield percentage: 59.11 %, lean meat content of carcasses: 70,9 %) indicate a high quality of production level, and selection based on differences between progeny groups is reassuring.

Results of experiments gave an answer to the question how the ranks resulted by domestic progeny test and international estimation correlate to each other. Rank correlation coefficients showed that there was a medium correlation between the ranks of breeding values of bulls calculated by the two different methods. This fact warns to be careful when evaluating beef breeding values of imported bulls (semen). International INTERBULL breeding value is the most suitable for making comparisons between bulls, which is a breeding value estimation carried out on the own base of each INTERBULL member countries.

It can be concluded that development of breeding value estimation – above all, the introduction of progeny test, and a selection method involving results from a uniform approach – gives a chance to keep the present level or even reach an improvement in fattening and slaugtering parameters, besides the milk production traits in Hungarian Simmental breed. However, further examinations are needed to support present results.

5. ÚJ TUDOMÁNYOS EREDMÉNYEK

1. It was concluded that main genetic parameters (heritability, correlations) of beef production traits of Hungarian Simmantal breed have not changd significantly under the consequent selection for dairy traits during the last decades.

2. To develop breeding value estimation for beef production traits, a progeny testing system was elaborated for domestic conditions. Genetic and environmental effects affecting the variances of different parameters were determined as well as their rate of influence. The method has been applied by the Association of Hungarian Simmental Cattle Breeders since 2004.

3. Adapting the breeding value estimation method applied in Simmental breed-group, and using the domestic genetic parameters, a new breeding value calculation model was developed, by which domestic breeding bulls can be ranked more correctly.

4. Comparison of the author’s beef index-ranking for domestic Hungarian Simmental bull population with international breeding value ranking revealed a weak-medium correlation.

6. PUBLICATIONS RELATING TO THE DISSERTATION

Scientific publications:

In foreign language:

1. Szabó, F. - **Füller I.** - Fördős A. - Keller, K. - Bene, Sz. (2010): Weaning results of beef Hungarian Fleckvieh calves. 1. Environmental factors. Archiv für Tierzucht, 53. 1. 18-25.
2. Bene, Sz. - **Füller, I.** - Fördős, A. - Szabó, F. (2010): Weaning results of beef Hungarian Fleckvieh calves. 2. Genetic parameters, breeding values. Archiv für Tierzucht, MS380, (in press)
3. Fördős, A. - **Füller, I.** - Bene, Sz. - Szabó, F. (2010): Weaning performance of beef Hungarian Fleckvieh calves. 3. Genotype x environment interaction. Archiv für Tierzucht, MS381, (in press)
4. Kiss, B. – Bene, Sz. – Polgár, J. P. – Füller, I. – Stefler, J. – Szabó, F. (2010): Station performance test result of Hungarian Simmental Bulls. Acta Agraria Kaposvariensis. (megjelenés alatt)

In Hungarian language:

1. **Füller, I.** – Stefler, J. – Bene, Sz. – Kiss, B. – Fördős, A. – Szabó, F. – Polgár, J. P. (2009): Hizlalási és vágási paraméterek öröklődhetősége és tenyészértéke a mai magyar kettőshasznosítású magyartarka fajtában. Állattenyésztés és Takarmányozás, 58. 4. 315-325.
2. Bene, Sz. – Fekete, Zs. – Fördős, A. – **Füller, I.** – Rádli, A. – Török, M. – Wagenhoffer, Zs. – Polgár, J. P. – Szabó, F. (2009): Különböző genotípusú növendék vágómarhák növekedése, vágóértéke és húsminősége. 1. közlemény: Hizlalási és vágási eredmények. Állattenyésztés és Takarmányozás, 58. 1. 23-40.

3. Holló, G. – **Füller, I. –** Tóth, A. (2008): Magyartarka tenyészbikák hústenyészértékének összehasonlító elemzése. Acta Agraria Kaposvariensis, 12.
4. Kiss, B. –Bene, Sz. – **Füller, I.** – Fördős, A. - Polgár, J. P. – Szabó, F. (2010): Magyartarka növendék bikák sajátteljesítmény-vizsgálati eredménye. Álattenyésztés és Takarmányozás. 59. 1. 11-22.

Abstracts in proccedings

In Hungarian:

1. **Füller, I.** – Húth, B. (2003): Hús ÍTV a magyartarka fajtában. X. Állattenyésztési napok. Nemzetközi Szarvasmarhatenyésztési Tanácskozás. (szerk. Béri, B. – Farkas, B) 99-105.
2. Hornyák, Z. - Polgár, J. P. - Lengyel, Z. - **Füller, I.** (2005): Magyartarka növendék bikák rostélyos keresztmetszetének vizsgálata XI. Ifjúsági Tudományos Fórum. Keszthely, 2005. március 24. CD kiadvány, I/120., 1-5.

Documentary publications:

In Hungarian:

1. **Füller, I.** – Polgár, J. P. – Harmat, Á. – Húth, B. – Lengyel, Z. (2002): Beszáoló a hús ITV eredményeiről. A magyartarka. 2. 3.
2. **Füller, I.** – Polgár, J. P. – Harmat, Á. – Húth, B. – Lengyel, Z. (2003): Beszámoló a hús ITV eredményeiről. A magyartarka. 3. 1.

Presentations:

In foreign language:

1. **Füller, I.** (2003): Bericht über die Ergebnisse die einheitliche Exterieurprüfung. Grub, 2003. október 17-18.
2. **Füller, I.** (2005): Bericht über die Ergebnisse die einheitliche Exterieurprüfung. Treviso, 2005. április 14-15.
3. **Füller, I.** (2000): Bericht über die Ergebnisse die einheitliche Exterieurprüfung. Grub
4. **Füller, I.** (2004): The current problems of the Fleckvieh breeding in the Europe. Fleckvieh in Hungary. Domasov, (CZ) 2004. szeptember 1

In Hungarian:

1. Lengyel, Z. - **Füller, I.** - Szabó, F. - Komlósi, I. - Polgár, J. P. (2004): Tenyészérték becslés egyedmodellel egy magyartarka tenyészetben. X. Ifjúsági Tudományos Fórum, Keszthely 2004. április 29.
2. **Füller, I.** - Polgár, J. P. - Hornyák, Z. - Lengyel, Z. (2004): Magyartarka növendék bikák vágási adatainak értékelése. XLVI. Georgikon napok 2004. szeptember 16-17.
3. **Füller, I.** – Húth, B. (2003): Hús ÍTV a magyartarka fajtában. Nemzetközi Szarvasmarhatenyésztési Tanácskozás, Debrecen 2003. augusztus 18-19.
4. **Füller, I.** - Polgár, J. P. - Hornyák, Z. - Lengyel, Z. (2004): Új kihívások, új lehetőségek a mezőgazdaságban. Magyartarka növendék bikák vágási adatainak értékelése. XLVI. Georgikon napok p.: 29.

Posters:

In foreign language:

1. Polgár, J. P. - **Füller, I**. - Húth, B. - Lengyel, Z. - Stefler, J. (2004): The evalution of the fattening and slaughter results of the Hungarian Simmental bulls, 55th EAAP, Bled, 2004. augusztus 05-09.
2. Polgár, J. P. - **Füller, I.** – Török, M. - Bene, Sz. – Kiss, B. – Harmat, Á. – Húth, B. (2007) Examination of slaugter results of Hungarian Simmental paternal half-sib bulls. EAAP Dublin, 2007. augusztus 29.
3. Kiss, B. – Bene, Sz. – Fördős, A. – Polgár, J. P. – Szabó, F. – **Füller, I.** (2009): The fattening result of Hungarian Simmental bulls int he self performance test. Európai Hegyitarka Tenyésztők Szövetsége 28. Kongresszus, Siófok, 2009. szeptember 24.
4. Tórh, A. – Holló, I. – **Füller, I.** – Holló, G. (2009): Comparative analysis of beef merit index of Hungarian Simmental sires. Európai Hegyitarka Tenyésztők Szövetsége 28. Kongresszus, Siófok, 2009. szeptember 24.

In Hungarian:

1. Polgár, J. P. - Hornyák, Z. - Lengyel, Z. - **Füller, I.** (2005): Magyar tarka bikák rostélyos keresztmetszet nagyságának összefüggése hízlalási és vágási paraméterekkel, Georgikon Napok CD kiadvány ISBN 963 9639 03 6, 1-5. pp

Professional articles:

In Hungarian:

1. Kiss, B. – **Füller, I.** – Bene, Sz. – Polgár, J. P. – Szabó, F. (2009): Magyartarka növendék bikák sajátteljesítmény-vizsgálati eredménye. A magyartarka. 9. 2. 19.

2. Tőzsér, J. - **Füller, I.** - Bedő, S. (2003): 6.1.2. Magyartarka fajta. p.121-136. Történelmi állatfajtáink enciklopédiája Tőzsér, J. Bedő, S. (szerk.)